Definitions and Interpretation of Poor Quality Value

Applicable Products

This document covers the following NeuroSky ThinkGear Products:

- TGEM2 (ThinkGear-EM2) with Firmware version 1.7.9 or later
- TGAM1 (ThinkGear ASIC Module)
- TGAT1 (ThinkGear ASIC)

In the document, these will be collectively referred as product.

Features

This document addresses the following:

- Explains how to interpret the Poor Quality value.
- Explains how the Poor Quality value behave and how it affects the eSense algorithm.
- Explains how to integrate the Poor Quality value into an application.

Introduction

In the product, the Poor Quality value is a flag system, where if one particular characteristic of the brainwave does not meet the specific criteria, the corresponding flag is raised. There are specific numbers assigned to each flag. The criteria are designed to be relatively lenient so the eSense values continue to function under sub-optimum condition. This leaves the freedom for the customer to design the application to be more stringent by using the poor signal quality value in conjunction with the eSense values.

Poor Quality Definitions & Integrations

Poor Quality Flags and Values

The table below lists all the characteristic of the brainwaves that are being monitored by the product and the associated flag values.

Wave Characteristic	Value
Signal Flatness	25
Signal Excessiveness	26
Power Ratio	27
Off-Head Detection	29

Multiple flags can be notified at the same time; for example Poor Quality = 51 means the brainwave failed both the flatness and excessiveness criteria. The flag values were chosen to make the sum of every combination a unique number.

One additional value to take note of is 200. This value only occurs after there are 4 seconds of off-head.

Poor Quality Interpretations

Signal flatness: Checks the amount of EEG signal in the sensed data. Flatness will be flagged if the EEG signal is lacking. This is usually flagged when there is an extreme amount of motion that causes saturations when the headset is worn.

Signal excessiveness: Checks the amount of noise in the signal. This is usually flagged when there is an extreme amount of EMGs or headset movement.

Power Ratio: This is a check done in the frequency domain. This is usually flagged when there is excessive periodic environmental noise in the signal.

Off-Head Detection: Checks if the headset is actually on a head. This can be triggered if the headset is not worn properly or not worn at all.

Poor Quality Behavior

The Poor Quality value output is derived by applying several quality matrices on the measured EEG signal. It is a number from 0 to 200 with 0 being the best quality, and 200 the worst. When the signal quality is poor, the calculated eSense Attention and Meditation values are not accurate. An extended period of poor signal quality can further confuse the adaptive eSense algorithm and can cause inaccuracies long after the signal quality improves. Thus, an automatic reset mechanism is built into the product to reset the eSense meters after an extended period of off-head or poor signal quality.

When a product is initially powered, it will go through an initialization of the eSense. The eSense values will stay at 0 until the product senses 4 seconds of data with a Poor Quality value of 0. After the product is initialized, the eSense values will start at 40 and varies according to the user's emotional state after that.

Under regular operation the eSense values are only updated when the Poor Quality value is 0. When the Poor Quality value is nonzero, the eSense value is not updated and stays at the previous known good value. When the Poor Quality value exceeds 50 for 7 consecutive seconds, the eSense will reset to zero. The product will go back to the initialization step and look for 4 seconds of Poor Quality value of 0 before getting back into normal operation.

When the off-head (value = 29) happens for 4 consecutive seconds, the eSense will reset to zero and the Poor Quality value will become 200 for this special case. Once again, the product will go back to the initialization step and look for 4 seconds of Poor Quality value of 0 before getting back into normal operation.

Poor Quality Integration

Since the eSense values are closely related to the Poor Quality value, the poor quality value can give you extra information on why the product (headset) is malfunctioning. The signal quality can be used to notify the user the headset is not being worn or used correctly. For example, if the signal flatness is flagged, the application can notify the user to check if the headset is loose or reduce his movement.

Another example of using the signal quality is to make the application stop as soon as the headset is taken off. Currently the eSense meter does not reset to zero, until it collects 4 consecutive seconds of off-head. Before that, the eSense values just freezes. You can design your application to react to off-head condition more quickly by checking all the Poor Quality values that includes the value for off-head (value=29), which are: 29, 54, 55, 56, 80, 81, 82, and 107. After one or two consecutive values of the list above, the application can take action to stop the game before the eSense drops down to zero.

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